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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/819,296	03/27/2001	Wei Pan	SLA 0515	4061

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EXAMINER

VU, HUNG K

ART UNIT	PAPER NUMBER
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2811

DATE MAILED: 12/31/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/819,296

Applicant(s)

PAN ET AL.

Examiner

Hung K. Vu

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 07 October 2002.
- 2a) ☒ This action is FINAL. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 8-10 and 12-25 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 8-10 and 12-25 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ 6) ☐ Other:

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

The changes made to 35 U.S.C. 102(e) by the American Inventors Protection Act of 1999 (AIPA) do not apply to the examination of this application as the application being examined was not (1) filed on or after November 29, 2000, or (2) voluntarily published under 35 U.S.C. 122(b). Therefore, this application is examined under 35 U.S.C. 102(e) prior to the amendment by the AIPA (pre-AIPA 35 U.S.C. 102(e)).

Claims 8-10, 12-14, 16-18, and 20-25 are rejected under 35 U.S.C. 102(e) as being anticipated by Lopatin et al. (PN 6,368,954, of record). Note Figures 1-9 of Lopatin et al.. Lopatin et al. discloses a method of manufacturing a multi-layered barrier metal thin film by atomic layer chemical vapor deposition comprising the steps of,

providing a substrate (200) in a reactant chamber;

providing a first chemical species (titanium, tantalum, tungsten) in the reactant chamber;

providing a second chemical species (ammonia, etc.) in the reactant chamber;, wherein

the first and second chemical species react to deposit a barrier metal thin film of a metal nitride (401) on the substrate by atomic layer chemical vapor deposition;

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providing a third chemical species in the reactant chamber;

providing a fourth chemical species in the reactant chamber, wherein the third and fourth chemical species react to deposit a second layer of the barrier metal thin film of a second metal nitride on the first layer by atomic layer chemical vapor deposition, wherein the second metal nitride is different in thickness from the first metal nitride,

wherein the barrier metal thin film deposited on the substrate defines a thickness of less than 100 Angstroms. Note Col. 4, line 37 to Col. 5, line 40.

With regard to claims 9 and 17, Lopatin et al. discloses the method further comprising depositing a thin copper film (402,403,404) on the barrier metal thin film.

With regard to claim 10, Lopatin et al. discloses the thickness of the barrier metal thin film is equal to an atomic thickness of the metal nitride. Note Col. 4, lines 42-53.

With regard to claims 12, 18 and 24, Lopatin et al. discloses the barrier metal thin film and the second barrier metal thin film are each chosen from the group consisting of TiN, TaN, W, WN and Si₃N₄. Note Col. 4, line 54 to Col. 5, line 39.

With regard to claim 13, Lopatin et al. discloses the substrate comprises a trench having a bottom surface and a side wall, and wherein the barrier metal thin film is deposited on the bottom surface and the sidewall by atomic layer chemical vapor deposition such that the barrier metal

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thin film defines a blocking diffusion characteristic which is the same on the side wall and the bottom surface

With regard to claim 16, Lopatin et al. discloses the method further comprising providing a fifth chemical species in the reactant chamber and providing a sixth chemical species in the reactant chamber, wherein the fifth and sixth chemical species react to deposit a third barrier metal thin film of a metal nitride on the barrier metal thin film by atomic layer chemical vapor deposition.

Note Col. 4, lines 42-53.

With regard to claim 20, Lopatin et al. discloses the first chemical species comprises a metal halide and the second chemical species comprises a nitrogen containing gas. Note Col. 4, line 54 to Col. 5, line 28.

With regard to claim 25, Satta et al. discloses the method further comprising depositing a third layer of the first metal nitride on the second layer by atomic layer chemical vapor deposition, and depositing a fourth layer of the second metal nitride on the third layer by atomic layer chemical vapor deposition such that the multi-layered barrier metal thin film comprises alternating layers of the first and second metal nitride.

2. Claims 8-10, 12-18 and 20-25 are rejected under 35 U.S.C. 102(e) as being anticipated by Satta et al. (PN 6,391,785, of record). Note Figures 1-3 of Satta et al..

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Satta et al. discloses a method of manufacturing a multi-layered barrier metal thin film by atomic layer chemical vapor deposition comprising the steps of,

providing a substrate in a reactant chamber;

providing a first chemical species (titanium, tantalum, tungsten, etc.) in the reactant chamber;

providing a second chemical species (nitrogen, etc.) in the reactant chamber, wherein the first and second chemical species react to deposit a first layer of a barrier metal thin film of a first metal nitride (26) on the substrate by atomic layer chemical vapor deposition;

providing a third chemical species in the reactant chamber;

providing a fourth chemical species in the reactant chamber, wherein the third and fourth chemical species react to deposit a second layer of the barrier metal thin film of a second metal nitride on the first layer by atomic layer chemical vapor deposition, wherein the second metal nitride is different in thickness from the first metal nitride,

wherein the barrier metal thin film deposited on the substrate defines a thickness of less than 100 Angstroms. Note Col. 7, line 23 to Col. 10, line 46.

With regard to claims 9 and 17, Satta et al. discloses the method further comprising depositing a thin copper film (not shown, 18) on the barrier metal thin film. Note Col. 13, lines 38 to Col. 14, line 5.

With regard to claim 10, Satta et al. discloses the thickness of the barrier metal thin film is equal to an atomic thickness of the metal nitride.

With regard to claims 12, 18 and 24, Satta et al. discloses first layer of the barrier metal thin film and the second layer of the barrier metal thin film are each chosen from the group consisting of TiN, TaN, W, WN and Si₃N₄.

With regard to claim 13, Satta et al. discloses the substrate comprises a trench having a bottom surface and a side wall, and wherein the barrier metal thin film is deposited on the bottom surface and the sidewall by atomic layer chemical vapor deposition such that the barrier metal thin film defines a blocking diffusion characteristic which is the same on the side wall and the bottom surface

With regard to claim 15, Satta et al. discloses the method is conducted at a temperature in a range of 300 to 600C, at a pressure in a range of 0.001 to 1.0 torr, and wherein each atomic layer chemical vapor deposition step is conducted for a time period in a range of 0.4 to 5.0 seconds. Note Tables 1 and 2, Col. 11, line 65 to Col. 12, line 11.

With regard to claim 16, Satta et al. discloses the method further comprising providing a fifth chemical species in the reactant chamber and providing a sixth chemical species in the reactant chamber, wherein the fifth and sixth chemical species react to deposit a third barrier metal thin film of a metal nitride on the barrier metal thin film by atomic layer chemical vapor deposition. Note Col. 10, lines 35-46

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With regard to claim 20, Satta et al. discloses the first chemical species comprises a metal halide and the second chemical species comprises a nitrogen containing gas.

With regard to claim 25, Satta et al. discloses the method further comprising depositing a third layer of the first metal nitride on the second layer by atomic layer chemical vapor deposition, and depositing a fourth layer of the second metal nitride on the third layer by atomic layer chemical vapor deposition such that the multi-layered barrier metal thin film comprises alternating layers of the first and second metal nitride.

3. Claims 21-25 are rejected under 35 U.S.C. 102(e) as being anticipated by Leem (PN 6,284,646). Note Figure 2C of Leem.

Leem discloses a method of manufacturing a multi-layered barrier metal thin film by atomic layer chemical vapor deposition comprising the steps of,

providing a substrate (17) in a reactant chamber;

depositing a first layer of a first metal nitride (22, 26) on the substrate by atomic layer chemical vapor deposition; and

depositing a second layer of a second metal nitride (22,26) on the first layer by atomic layer chemical vapor deposition;

wherein the first metal nitride is different from the second metal nitride. Note Col. 5, line 15 – Col. 6, line 65.

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With regard to claim 22, Leem discloses the method further comprising depositing a third layer of a third metal nitride on the second layer by atomic layer chemical vapor deposition, wherein the third metal nitride is different from the first and the second metal nitrides. Note Col. 5, line 15 – Col. 6, line 65.

With regard to claim 23, Leem discloses the multi-layered barrier metal thin film (26) deposited on the substrate defines a thickness of less than 100 Angstroms. Note Col. 6, lines 45-46.

With regard to claim 24, Leem discloses the first and the second metal nitrides are each chosen from the group consisting of TiN, TaN, W, WN and Si₃N₄.

With regard to claim 25, Leem discloses the method further comprising depositing a third layer of the first metal nitride on the second layer by atomic layer chemical vapor deposition, and depositing a fourth layer of the second metal nitride on the third layer by atomic layer chemical vapor deposition such that the multi-layered barrier metal thin film comprises alternating layers of the first and second metal nitrides. Note Col. 5, line 15 – Col. 6, line 65.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 15 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lopatin et al. (PN 6,368,954, of record).

Lopatin et al. discloses all of the claimed limitations except the time period for conducting each atomic layer in the range of 0.4 to 5.0 seconds and the thickness of the first and second films.

Although Lopatin et al. does not teach the exact the time period and the thickness, as that claimed by Applicants, however, it would have been obvious to one having ordinary skill in the art at the time the invention was made to form the barrier during the time period and having the desire thickness, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

5. Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Satta et al. (PN 6,391,785, of record).

Satta et al. discloses all of the claimed limitations except the time period for conducting each atomic layer in the range of 0.4 to 5.0 seconds and the thickness of the first and second films.

Although Satta et al. does not teach the exact the time period and the thickness, as that claimed by Applicants, however, it would have been obvious to one having ordinary skill in the art at the time the invention was made to form the barrier during the time period and having the desire thickness, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

Response to Arguments

6. Applicant's arguments filed 10/07/02 have been fully considered but they are not persuasive.

It is argued, at pages 8-9 of the Remarks, that neither Lopatin et al. nor Satta et al. discloses the second metal nitride is different from the first metal nitride. This argument is not convincing because the claimed language does not state "different" in what (thickness, material, composition, etc.). As in this case, Lopatin et al. discloses, at shown in Col. 4, line 54 – Col. 5, line 39, the second metal nitride is different in thickness from the first metal nitride. Satta et al. discloses, at shown in Col. 7, line 23 – Col. 10, line 46, the second metal nitride is different in thickness from the first metal nitride. Therefore, Applicants' claims 8, 14 and 21 do not distinguish over the cited references.

Conclusion

7. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event,

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however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hung K. Vu whose telephone number is (703) 308-4079. The examiner can normally be reached on Mon-Thurs 7:00-4:30 and every other Friday 7:00-3:30, Eastern Time.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas can be reached on (703) 308-2772. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 308-7722 for regular communications and (703) 308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

Vu

December 24, 2002

Steven Loke
Primary Examiner
Steven Loke